period were exceptionally heavy and resulted in devastating floods in Texas and Oklahoma. The persistent low pressure over the interior caused in the Eastern States a continuation of southerly winds and abnormally high temperature until the arrival in that section of a disturbance that appeared near Santo Domingo, W. I., on the 24th. This disturbance arrived off the North Carolina coast on the 29th, reached the neighborhood of New York, N. Y., the night of the 30th, and past thence northeastward over the Canadian Maritime Provinces. The gales that attended its passage along the Carolina and middle Atlantic coasts were severe, and due and timely notice was given of their occurrence.

Following the northeastward passage of the West Indian storm an area of high barometer and cool, fair weather advanced from the British Northwest Territory over the Lake region and north-central valleys at the close of the month.

During the last six days of the month a barometric depression, a typhoon, apparently advanced from west of Luzon, Philippine Islands, toward the Japanese coasts.

BOSTON FORECAST DISTRICT.*

[New England.]

The month was warmer than usual and there was more than the usual amount of precipitation. The first decade of the month was cool and temperature was generally above the normal during the remainder of the month. On the 2d and 3d temperature thruout the section was near or slightly below freezing, and on the 26th maximum readings between 85° and 90° were noted. Storm warnings were displayed on the 6th and 30th, and were fully justified. There were no storms for which warnings were not ordered.—*J. W. Smith, District Forecaster.*

NEW ORLEANS FORECAST DISTRICT.*

[Louisiana, Texas, Oklahoma, and Arkansas.]

The first decade of the month was cool and frost, for which warnings were issued, occurred in the northwestern part of the district on three dates. During the latter half of the month temperature was above normal. No general storms occurred on the Gulf coast and no storm warnings were issued.—*I. M. Cline, District Forecaster.*

LOUISVILLE FORECAST DISTRICT.*

[Kentucky and Tennessee.]

The month opened cold, with heavy frost in Kentucky and northern Tennessee and light frost in southeastern Tennessee the morning of the 1st. Abnormally cold weather in the first decade was followed during the balance of the month by abnormally high temperature. Rainfall was about normal in Kentucky and below normal in Tennessee. No special warnings were issued.—*F. J. Walz, District Forecaster.*

CHICAGO FORECAST DISTRICT.*

[Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, and Montana.]

Rainfall was exceptionally heavy over the greater portion of the district. During the early part of the month temperature was considerably above normal, while later it was above normal in the eastern and below in the western portions. Storm warnings were issued to upper Lake ports several times during the month, and while the warnings were, as a rule, verified there were no exceptionally severe storms, except in the case of a few thundersqualls. Verified frost warnings were issued during the first decade, and again during the third decade for a few of the Northwestern States.—*H. J. Cox, Professor and District Forecaster.*

DENVER FORECAST DISTRICT.*

[Wyoming, Colorado, Utah, New Mexico, and Arizona.]

In northern Utah and parts of Wyoming rainfall was heavy. At Salt Lake City the amount was the greatest of record for May. Temperature was lower than usual and frost was frequent, except in extreme southern portions of the district. Warnings of the frosts were given in the regular forecasts, and for severe frosts and freezing temperatures general and more effective distributions were made. As a result of heavy rainfalls, rivers in Wyoming reached high stages. Owing to the light winter snowfall and cool weather, stages in the Colorado and Rio Grande rivers were much lower than usual, while discharges from the Arkansas and South Platte rivers were insufficient to meet the needs of irrigation enterprises. —*F. H. Brandenburg, District Forecaster.*

SAN FRANCISCO FORECAST DISTRICT.†

[California and Nevada.]

The month began with unsettled weather that was followed thru the first decade by fair weather. The second decade of the month was unsettled and unusually cold. Very high northwest winds were frequently reported along the coast from Point Reyes northward.—*A. G. McAdie, Professor and District Forecaster.*

PORTLAND, OREG., FORECAST DISTRICT.†

[Oregon, Washington, and Idaho.]

The month was marked by excessive cloudiness and unseasonably low temperature. On the 1st warnings were issued for a storm that past over the district on the 2d. Light frosts were of frequent occurrence but were of a local character, except on the 13th, 17th, and 23d, when they were general over the eastern portion of the district.—*L. Lodholz, Local Forecaster, temporarily in charge.*

RIVERS AND FLOODS.

The morning weather map of May 21 showed a depression over western Texas, and a moderate high area over the lower Missouri Valley. During May 22 and 23 the depression moved slowly eastward over southern Texas, and relatively high pressure continued to the northeastward and eastward. On the morning of May 24 the Texas depression had about disappeared, but there was another over northern New Mexico, with a high area over Lake Superior. During the 22d heavy rains fell in the Texas Panhandle, Oklahoma, and the extreme northern portion of eastern Texas. These heavy rains continued during the night of the 22d and extended into the upper watersheds of the Brazos and Trinity rivers, 4.44 inches falling at Abilene, Tex., during the night of the 22–23d. More heavy rains fell in Oklahoma and that portion of the Red River Valley immediately to the southward, continuing during the night of the 23d at an excessive rate, and extending thruout Texas generally. During the twenty-four hours ending at 8 a. m., May 24, the precipitation over eastern Texas ranged from 1½ to over 6 inches. On the morning of the 25th there was a well-defined depression over the Dakotas and Nebraska, and the rains in Texas had ceased. The following map (fig. 1) shows the amount and distribution of the rainfall over the State of Texas from May 21 to 24, inclusive.

Such torrential downpours could have but one result, and the floods that followed were the greatest and most destructive ever recorded in the history of the State of Texas. Over the watershed of the Colorado River the rainfall was not as heavy as over the watersheds of the Brazos and Trinity rivers, and the rise in the former river was not important except below Austin. At Columbus the maximum stage was 33.8 feet on the 30th, 9.8 feet above the flood stage, but no flood stages were reported from places any considerable distance above.

Owing to the excessive rate at which the rain fell on the 23d the first rush of flood waters in the Brazos and Trinity rivers came very suddenly. At Kopperl, on the Brazos River, 60 miles above Waco, the gage reading on the morning of May 23 was only 1.2 feet, but by the morning of the 24th it

* Morning forecasts made at district center; night forecasts made at Washington, D. C.

† Morning and night forecasts made at district center.

was 22 feet, or 1 foot above the flood stage, showing a rise of 20.8 feet in twenty-four hours. At 8 p. m., of the same date, a record-breaking crest stage of 34 feet was reached, making a total rise of 32.8 feet in about thirty-eight hours, a most remarkable rise for so large a river. By the morning of the 25th the river had fallen to 21.6 feet. There was a secondary rise of about 5 feet on the 26th and 27th, after which there was a rapid decline. At Waco there was a rise of 28.7 feet from 6 a. m. of the 23d to 2:40 p. m. of the 24th, at which latter time the stage of water was 36.7 feet, 12.7 feet above flood stage, and the highest stage of record, exceeding by 1.1 feet the previous high-water stage of May 28, 1885. The river remained above the flood stage until the evening of the 28th. At Valley Junction, 70 miles below Waco, the river past the flood stage of 40 feet during the 25th, reaching a crest stage of 50.9 feet on the 27th. At the end of the month the river was still rising from Hempstead southward, with stages closely approximating the flood stage.

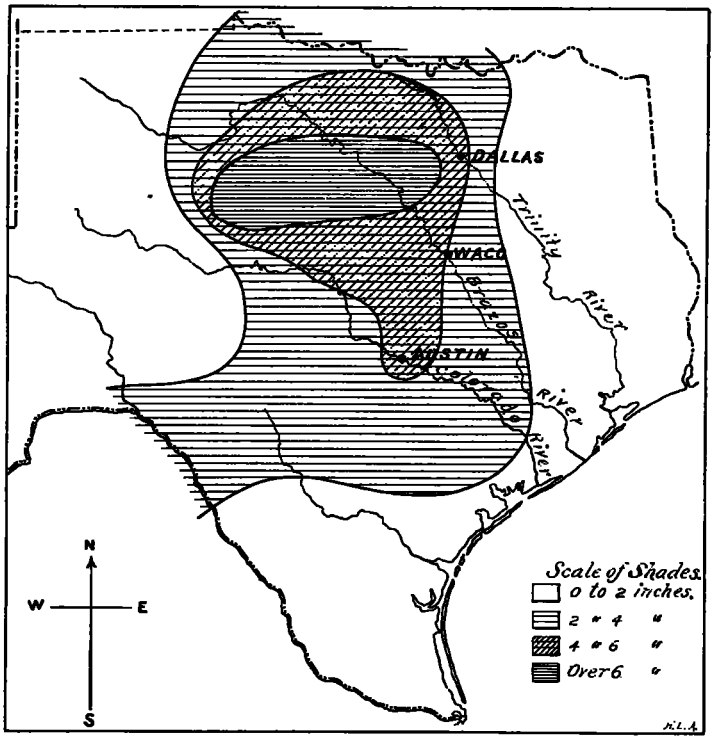

FIG. 1.—Rainfall distribution in Texas, May 21 to 24, inclusive.

The behavior of the Trinity River was very similar to that of the Brazos, but the flood was of greater proportions and much more destructive. At Dallas, at 6 a. m. of the 22d, the river stood at 10.5 feet; it past the flood stage of 25 feet during the early morning of the 24th, and crested at 52.6 feet at 6 p. m. of the 25th, with a total rise of 42.1 feet, and a crest stage only 3.9 feet below the great stage of June, 1866. At the end of the month the river was still above the flood stage. Below Dallas the rise was not so great, altho flood stages were general, exceeding in many places the highest stages previously recorded. From Long Lake southward a second pronounced rise set in on the 28th, and it was still in progress at the close of the month.

The upper Neches River was also affected by the heavy rains, and at Rockland it was above the flood stage of 20 feet from the 20th until the end of the month, with a crest stage of 25 feet on the 25th. This is the highest stage of record.

The upper Sabine River was in flood from the 15th until after the end of the month on account of heavy rains that fell from the 12th to the 17th, inclusive. The crest stages, however, were not unusual.

The Guadalupe and other smaller rivers of southeastern Texas also contributed to the general disturbance, but not to an alarming extent.

The usual difficulty has been encountered in obtaining data regarding the losses of life and property by this flood. It is known that at least 8 persons were drowned at Dallas, and 3 at or near Fort Worth. Nearly 5,000 persons were driven from their homes in Dallas, and 600 houses were vacated at Fort Worth, household effects being left behind and ruined in most instances. Other losses were those usually incident to great floods. Roughly speaking, the actual losses at Dallas amounted to $1,500,000, and at Fort Worth, $500,000. This is exclusive of railroad losses which must have amounted to at least $500,000, and of commercial losses occasioned by the blocking of freight and the suspension of business. With the losses outside the two cities considered, the total from all causes must be not less than $5,000,000.

The heavy rains from the 22d to the 24th, inclusive, also extended into Oklahoma, Oklahoma City reporting a total precipitation of 6.96 inches during the forty-eight hours ending at 6 a. m. of the 24th. Practically every stream in the State was above flood stage; many were higher than ever before, and the flood, considered as a whole, was probably the greatest in the history of the State. A number of lives were lost, and the property losses were enormous. Farm lands and houses were submerged, railway bridges and roadbeds and highway bridges and roads were carried away or washt out, gas mains were broken, plunging cities into darkness, and manufacturing plants were demolished. Owing to the fact that organized flood service is not maintained over the greater portion of Oklahoma, it has been impossible to obtain detailed statements of the losses occasioned by the floods. They must have amounted to several millions of dollars, not including the very large amounts necessary for repairs and reconstruction and the losses suffered thru the enforced cessation of business of every nature.

While the floods did not extend north of the Oklahoma-Kansas line, they extended eastward into the lower Neosho, lower Canadian, and the Arkansas rivers. At Calvin, Okla., on the Canadian River, the highest stage reached was 17.2 feet, 7.2 feet above the flood stage. The Neosho River from the Kansas line southward was above flood stage from the 24th to the 27th, inclusive, with a maximum stage at Fort Gibson, Okla., near the mouth of the river, of 35 feet on the 25th, 13 feet above the flood stage.

The Arkansas River went above the flood stage of 16 feet at Tulsa, Okla., on the 24th, and by the 28th the first flood tide had reached Pine Bluff, Ark. The greatest rise occurred in the heavy rain belt between Webbers Falls, Okla., and Fort Smith, Ark., where the crest stages were from 9 to 11 feet above the flood stage. Warnings of this flood were issued in ample time, except along the lower Canadian River, where the suddenness of the rise prevented an effective warning. Reports received indicate that the warnings were of great value and were the means of saving a large amount of property. Movable property to the value of about $250,000 was saved, and the strengthening of levees upon advices given by the Weather Bureau prevented the overflow of several thousands of acres of growing crops. The principal losses were to crops, mills, and cut lumber. River business was, of course, suspended and it was not actually resumed until June 19. The money value of property saved was about $1,000,000, one-half above, and one-half below Fort Smith. The losses and damage amounted to about $250,000, 90 per cent of which was suffered by the farmers, and to these figures should be added a further loss of about $75,000 occasioned by the suspension of business. As far as could be learned, no material damage was done to farm lands by erosion or deposit.

The rise in the lower Arkansas River was not so great and

this fact, together with the timely warnings, prevented any damage of consequence.

The Black and lower White rivers of Arkansas were above flood stage thruout the month, and there was also a decided flood in the upper White River about the middle of the month.

When the great Red River flood began on the 25th, the more moderate one of the middle of the month was still in progress east of the Arkansas line. The great flood was in full progress at the close of the month, and a report thereon will appear in the MONTHLY WEATHER REVIEW for June, 1908.

Rains in the Kansas, Missouri, and Mississippi valleys were frequent and heavy, causing general rises in the rivers, but at the end of the month floods had not set in, except in the Mississippi River between Keokuk, Iowa, and Hannibal, Mo., and in some of the upper tributaries of the Mississippi, especially the St. Croix, Minnesota, and Illinois rivers. Warnings were issued at the proper times for these floods. The rise in the vicinity of Keokuk was mainly from the Des Moines River, and while considerable damage was done to crops, principally thru the breaking of a small private levee between the Des Moines River and the town of Alexandria, Mo., a four-inch deposit of rich soil offset the losses.

The lower Mississippi River was uniformly high, altho not dangerously so, except from New Orleans, La., southward.

The rise that began about the 7th in the upper Ohio River and tributaries did not result in flood stages, except from Evansville, Ind., to Cairo, Ill., where the flood lines were slightly exceeded. Not much direct damage was done, but farming operations, especially corn planting, were greatly delayed. Heavy rains from the 4th to the 6th, inclusive, also caused moderate floods in the Scioto and Great Miami rivers of Ohio, and the warnings issued for the same were fully verified. The damage done was not extensive.

The Grand River of Michigan was in moderate flood from the 9th to the 24th, inclusive. Advices were given when necessary, and there were no unpleasant features, except some slight inconvenience in the lowlands.

The rivers of the Gulf of Mexico system east of the Mississippi River were in flood during the early days of the month as a result of heavy general rains during the last few days of April. In fact the lower Flint and lower Chattahoochee rivers were already in flood at the beginning of May. Flood warnings were issued for the Flint, Chattahoochee, and Apalachicola rivers on April 27, and they were reported to have been of much value to the lumber, cattle, and mill interests. Floods of a similar character occurred in the Black Warrior and lower Tombigbee rivers, and in the Pascagoula and Pearl rivers of Mississippi, for which warnings were issued when indicated.

The Columbia River continued to rise thruout the month.

The highest and lowest water, mean stage, and monthly range at 215 river stations are given in Table IV. Hydrographs for typical points on seven principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Professor of Meteorology.*

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

WEATHER INFLUENCES PRECEDING THE EVACUATION OF BOSTON, MASS.[1]

By WALTER N. LACY. Dated Harvard University, May 11, 1908.

In a recent study of some climatic influences on American history the writer found reference to the weather conditions which played an important part in the closing history of the siege of Boston. A careful investigation of all available data on the subject led to the preparation of this paper and of the accompanying maps of the probable weather conditions in the vicinity of Boston for March 4, 5, and 6, 1776. The maps were drawn from the available data of the local weather conditions at the time and upon present knowledge of the nature, tracks, and velocity of storms in the eastern part of the United States. (See fig. 1.)

Following the battle of Bunker Hill and the arrival of General Washington as Commander-in-Chief in the summer of 1775, the continental forces kept a blockade around the city of Boston all thru the following winter. As spring advanced Washington resolved upon some effective move, and with the consent of his officers prepared to fortify Dorchester Heights, a position which so commanded Boston and the harbor as to make untenable the British position as long as the Americans occupied those heights. During the first few days of March, 1776, preparations were hurried for effecting Washington's plan, and on the nights of Saturday and Sunday, March 2 and 3, cannonading was kept up by the continental forces from Lechmeres Point, Cobble Hill, and Lambs Dam, Roxbury, near the present lead works on Albany street. (See the accompanying sketch map, fig. 2.)

[1] Part of a thesis prepared in the course in advanced climatology given by Prof. R. DeC. Ward, in Harvard University, during the year 1907-8. The references consulted in the preparation of this paper include histories of the United States, the Revolutionary War, and Boston; a memorial address on the Centennial of the Evacuation, by George E. Ellis, D.D.; published letters or journals of Lieut. William Carter of the British Army, George Washington, and Daniel McCurtin; manuscripts by Timothy Newell, Doctor Holyoke, and Professor Winthrop; and Prof. Edward B. Garriott's "Cold Waves and Frost in the United States." Grateful mention must also be made of the suggestions received from Mr. J. W. Smith, District Forecaster at Boston, Mass.

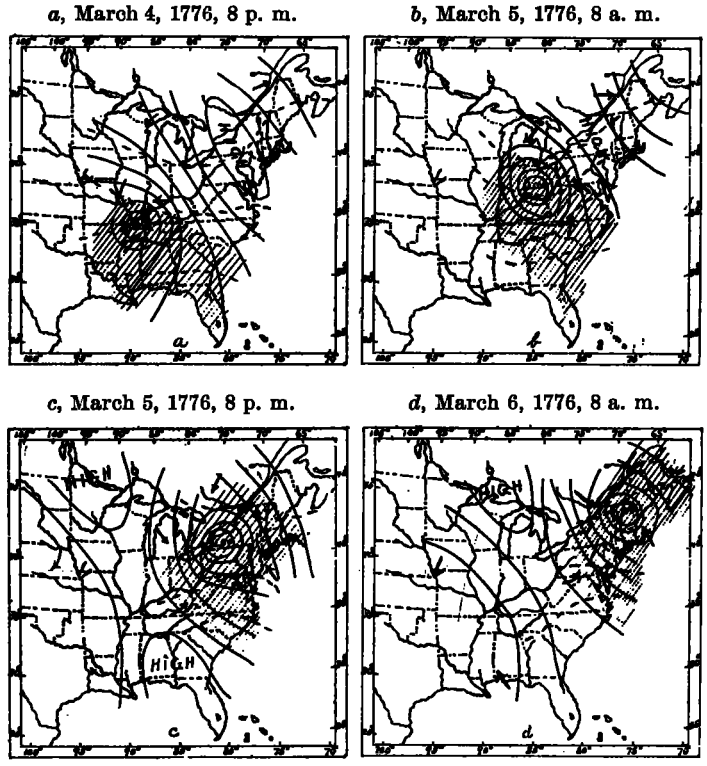

FIG. 1.—Maps showing probable weather conditions in eastern United States during operations preceding evacuation of Boston, Mass.

Monday evening, March 4, everything was in readiness and the night was unusually favorable for the execution of Washington's plan. Between 7 and 8 o'clock some two thousand men, including a covering party, moved toward Dorchester Heights, under command of General Thomas. The ground, to a depth of some 18 inches, was frozen so hard that it could not be thrown up as breastworks, and fascines and